6th International Symposium for Farming Systems Design

How far can soil fertility in agro-pastoral villages of west Africa be sustained by biomass flows?

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Introduction

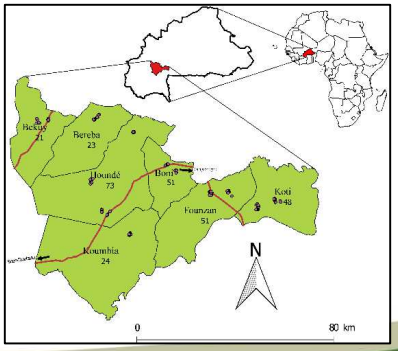
- West Africa : soil fertility depletion, low access to mineral fertilizer
- Free grazing of crop residue during the dry season

→ Biomass optimization (mulch, compost) (Corbeels et al., 2014; Tittonell et al., 2012)

→ Increase yield at farm scale (≈) BUT affect crop residue available for livestock

How introduction of mulch affect farming systems at farm and landscape scale ?

- Burkina Faso, Tuy province (800-1200 mm rainfall), Koumbia district



Modelling crop residue use

- Crop scale : Effect of mulch on crop productivity based on crop models : APSIM (Gaydon et al., 2011), DSSAT (Ngwira et al., 2014), STICS (Scopel et al., 2004),etc.
- Farm scale : Assessment of farmer's constraints & opportunities to implement mulch (livestock, labor, fertilizer, etc.), NUANCES-FARMSIM (Rusinamhodzi et al., 2015), LP models (Naudin et al., 2015), etc.

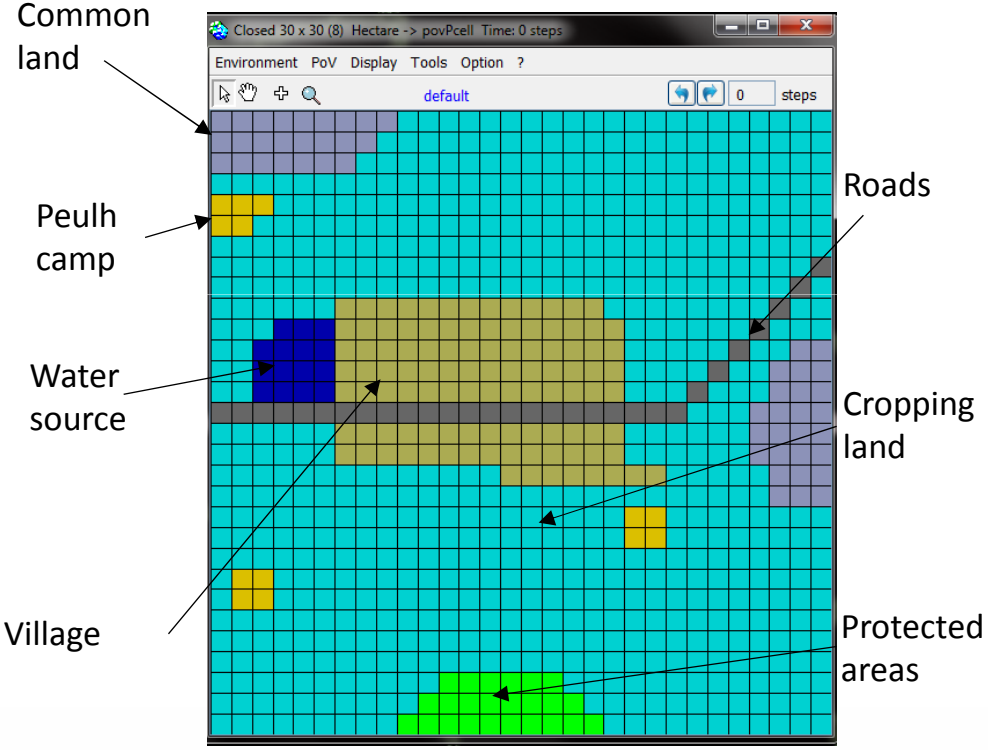
Capitalize on existing models' results
(basic assumptions)

- Landscape scale :
  - biomass & livestock flows in space and time
  - landscape structure
  - interaction between farms

Agent-based modelling

Let's set the scene !

Schematic Landscape



Farmers (n=100)

Pastoralists (PA) | Agro-pastoralists (AP) | Susbistence Oriented (SO) | Market Oriented (MO)

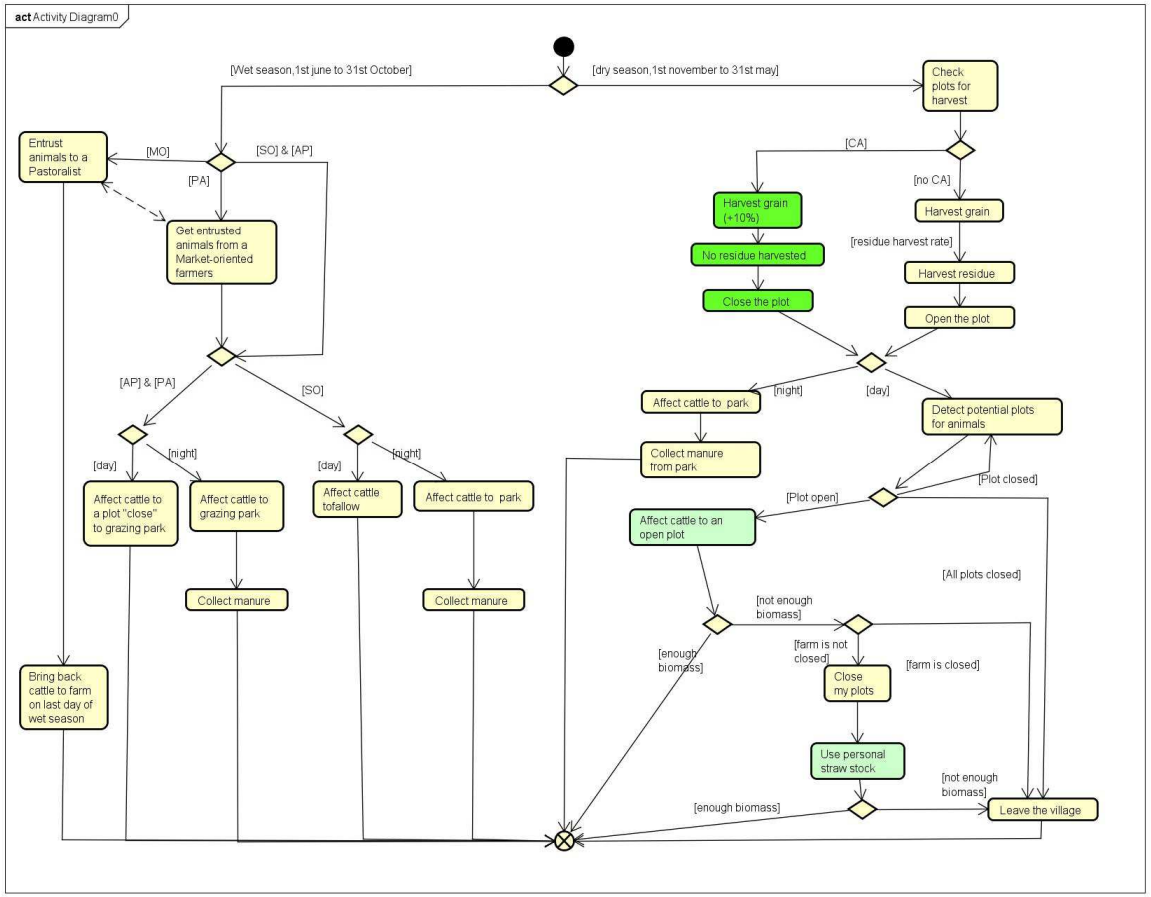
(Based on PCA-HC typology (Diarisso et al., 2015))

Crop scale : fertilizer user, manure use, residue collected

Farm scale : Decision to affect cows to fallow, communal land, leave the village

Village scale : livestock mobility (farmers' interaction)

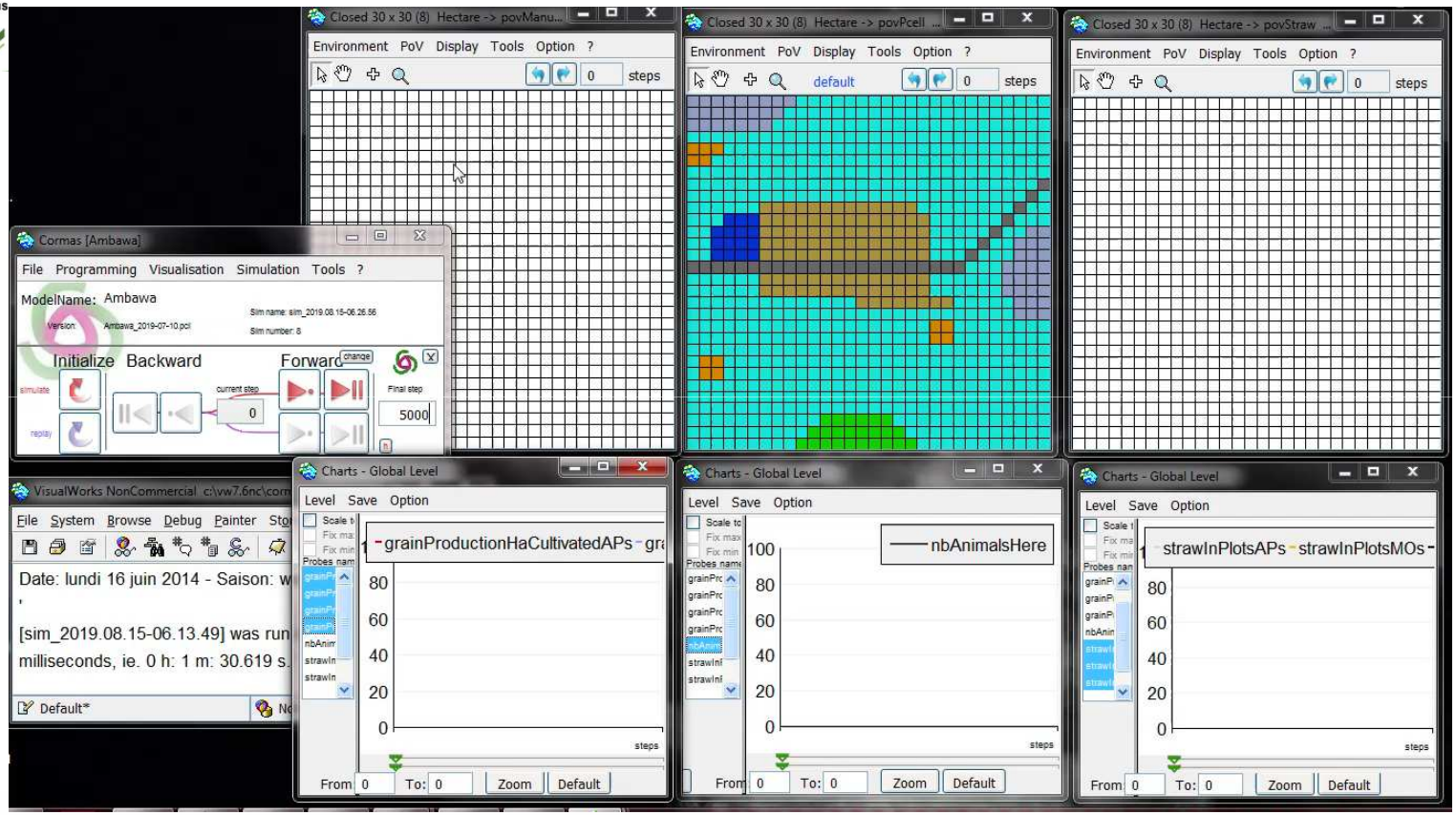
Farm scale : Activity diagram (UML)



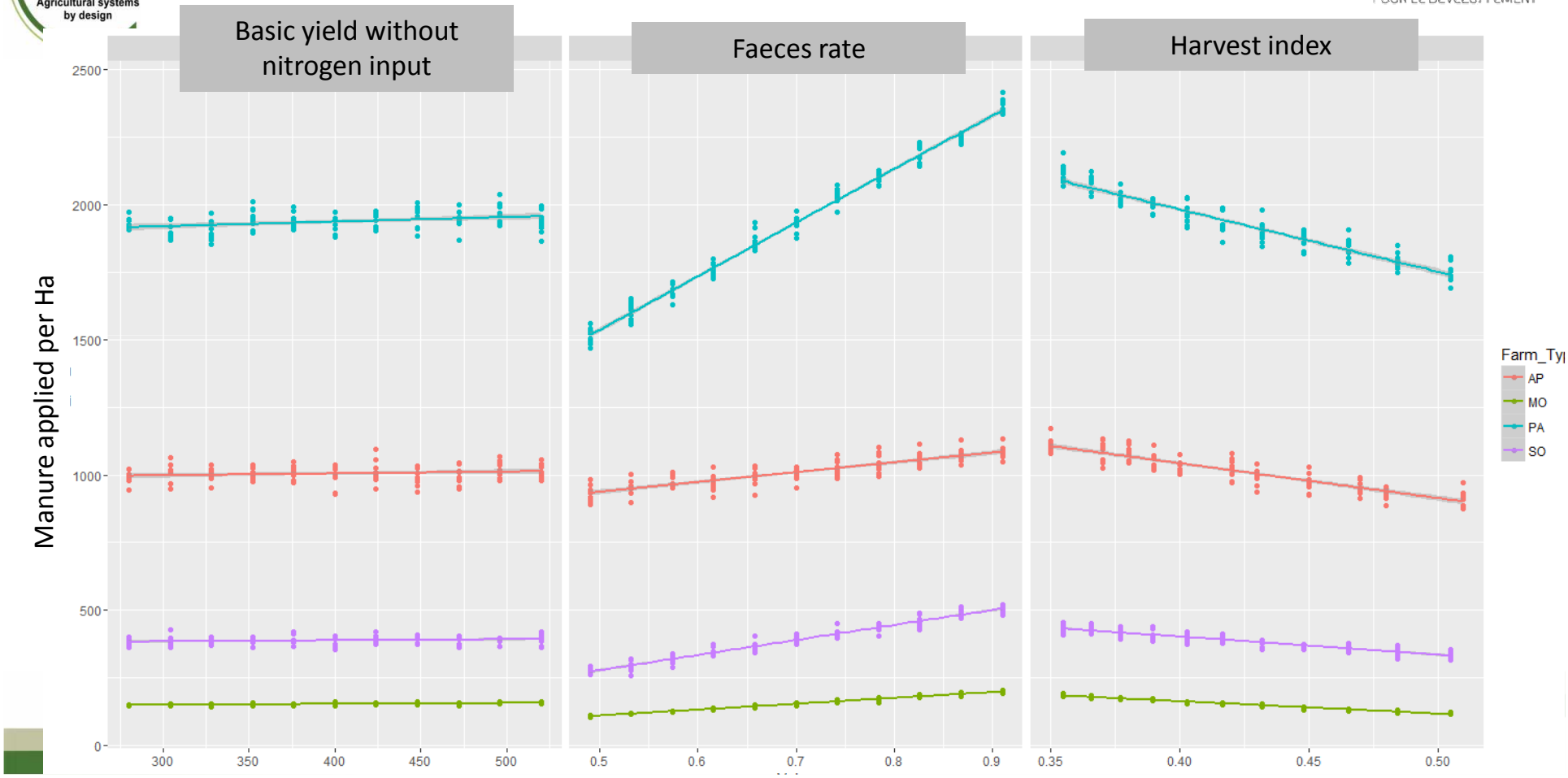
AP : Agro-pastoralist
MO : Market oriented
PA : Pastoralist
SO : Subsistance oriented

FaecalProduction = DailyFodderConsumption * RatioNightDay * faecesMax * nbHeads

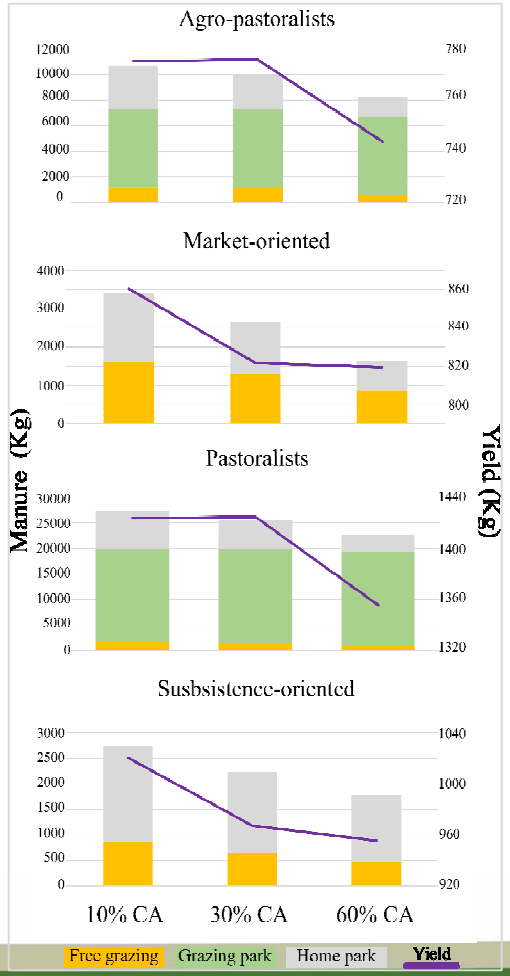
Concrete example



Sensitivity analysis



First results : Effect of mulch at farm and village scale



Assumption reminder : Mulch increase yield by 10%, but livestock cannot graze on it?

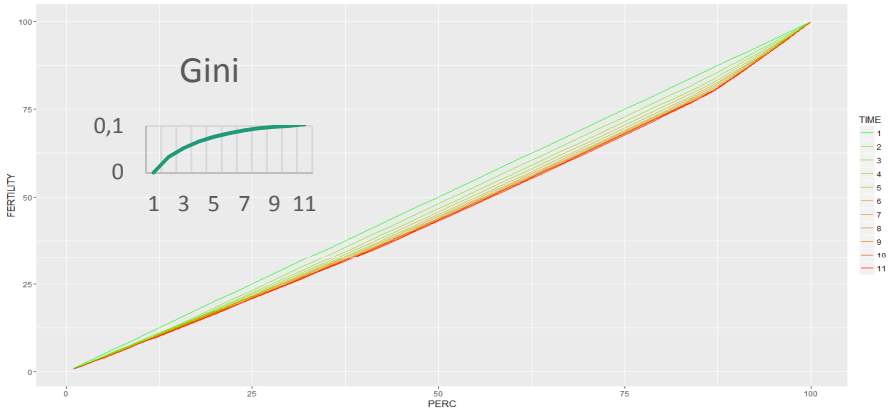
10% landscape under mulch to 60% : Yield loss by 4%; 4,2%; 5,5%; 6,4% for AP, MO, PA, SO

Yield increase by mulch is not enough to compensate feed loss for livestock owner and therefore manure loss when livestock leanes the villahe

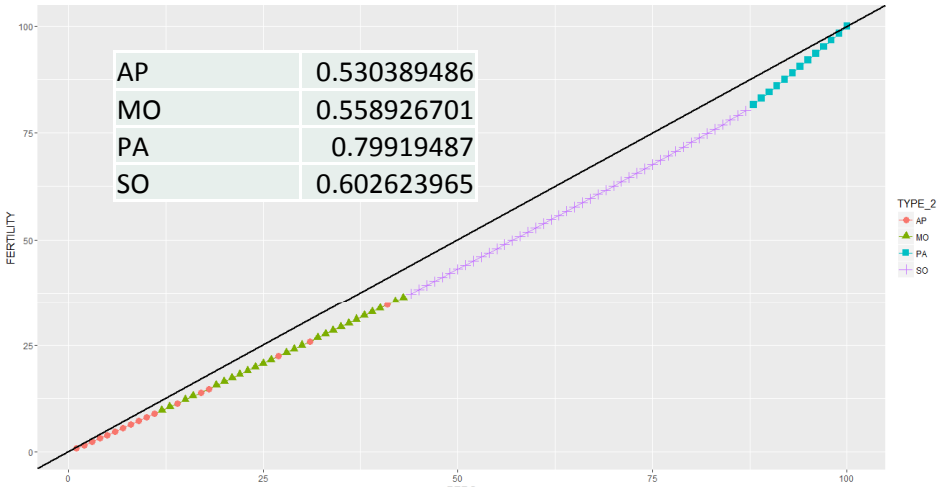
Is Mulch a “Landscape-smart” practices? For who?

First results : fertility distribution at village scale (Gini index, equity)

T=0 : All fertility levels = 1 (straight line y=x)



Inequity in fertility distribution increased after 10 years of simulation not very significant

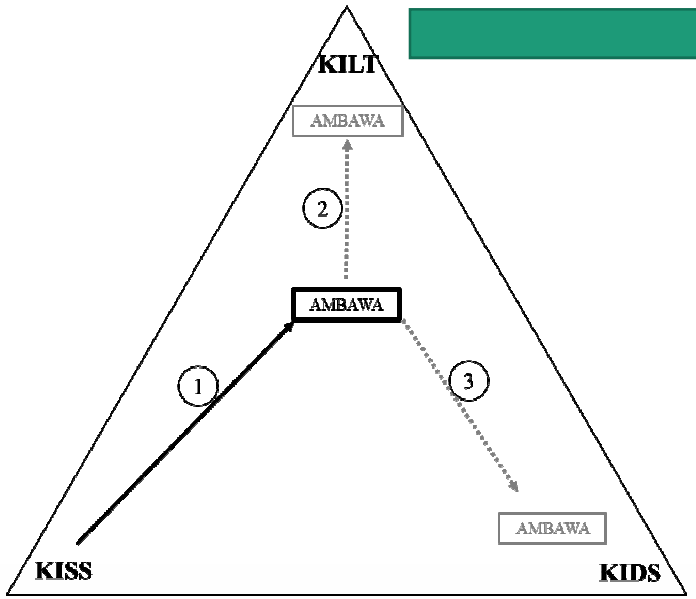


Livestock owner benefits from free grazing (but leave the village…)

Discussion and perspective

Limits :

- No alternative feeding strategies when residue are missing
- Farmers' interaction simplified
- Cropping systems and climate simplified



Project CASSECS (UE-DevCo)
Serious game

▲ *Le jeu de rôles Bagrépoly au Burkina Faso (nov. 2016). © Farid Traoré*

Phd Student Gildas Assogba (Biomass flows in Northern Burkina Faso)

Muchas Gracias